# VELOCITY

wati Itassam.

*Today we will be obtaining data to test our skills in finding velocity.*

*Materials: 1 smart cart, 1 fan, meter stick, and ramp*

*Procedure: break up into groups of 2 or 3. Find the material listed above. Find a place in the lab that will allow you to place the ramp flat (level). Place the cart at the end of the ramp. Attach the fan to the cart. Divide the ramp into 4 equal parts and mark on the side of the rap each division.*

*Turn on the computer and open the Capstone program. Synch the cart to the program. Practice turning on the program and releasing the cart. Check to see if the program is recording your position. Once you are comfortable with the program. Start your first run. Then take 2 more runs for a total of 3. Review the data and graph. Make a judgement and choose one run.*

*Analyze the data by completing the chart below. The data chart will give you your time and displacement. Since I do not know how long each .25 distance point is...you must make a judgement and enter the displacement points.*

***Remember - we want to use the change of velocity from each segment ($X_2 - X_1$).***

| DISTANCE (cm) | t (sec) | $\Delta X = X_2 - X_{1(cm)}$ | $\Delta t = t_2 - t_{1(s)}$ | $v = \Delta x/\Delta t$ (cm/s) |
|---|---|---|---|---|
| 0 distance | 0 | 0 | 0 | 0 |
| .25 of distance | 0.922 | 0.158 - -9.56e-2 = 0.255 = 25.5 cm. | 0.922s | 27.7 |
| .5 of distance | 1.36 | 0.405 - 0.158 = 0.247 = 24.7cm | 0.438s | 56.4 |
| .75 of distance | 1.72 | 0.652 - 0.405 = 0.247 = 24.7cm | 0.36s | 68.6 |
| end of ramp | 2.015 | 0.898 - 0.652 = 0.246 = 24.6 cm. | 0.295s | 83.4 |

# VELOCITY

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1) *Using the data make a graph of the change in position vs. time. When making the graph make a graph that uses most of the graph paper.*

2) *Using the data make a graph of the velocity vs. time experienced by the cart.*

3) *How does the total distance change as total time increase?*

Total distance increases

4) *Determine the average velocity of the cart over the entire length of the race?*

$\frac{100}{2.015} = 49.5$ cm/s.

5) *Using the displacement graph, use the slope of the cart from the starting point to the ending point and find the velocity of the cart?*

$\frac{100-0}{2.015-0} = 49.5$ cm/s

6) *Does the answer for question 4 match the answer for question 5.*

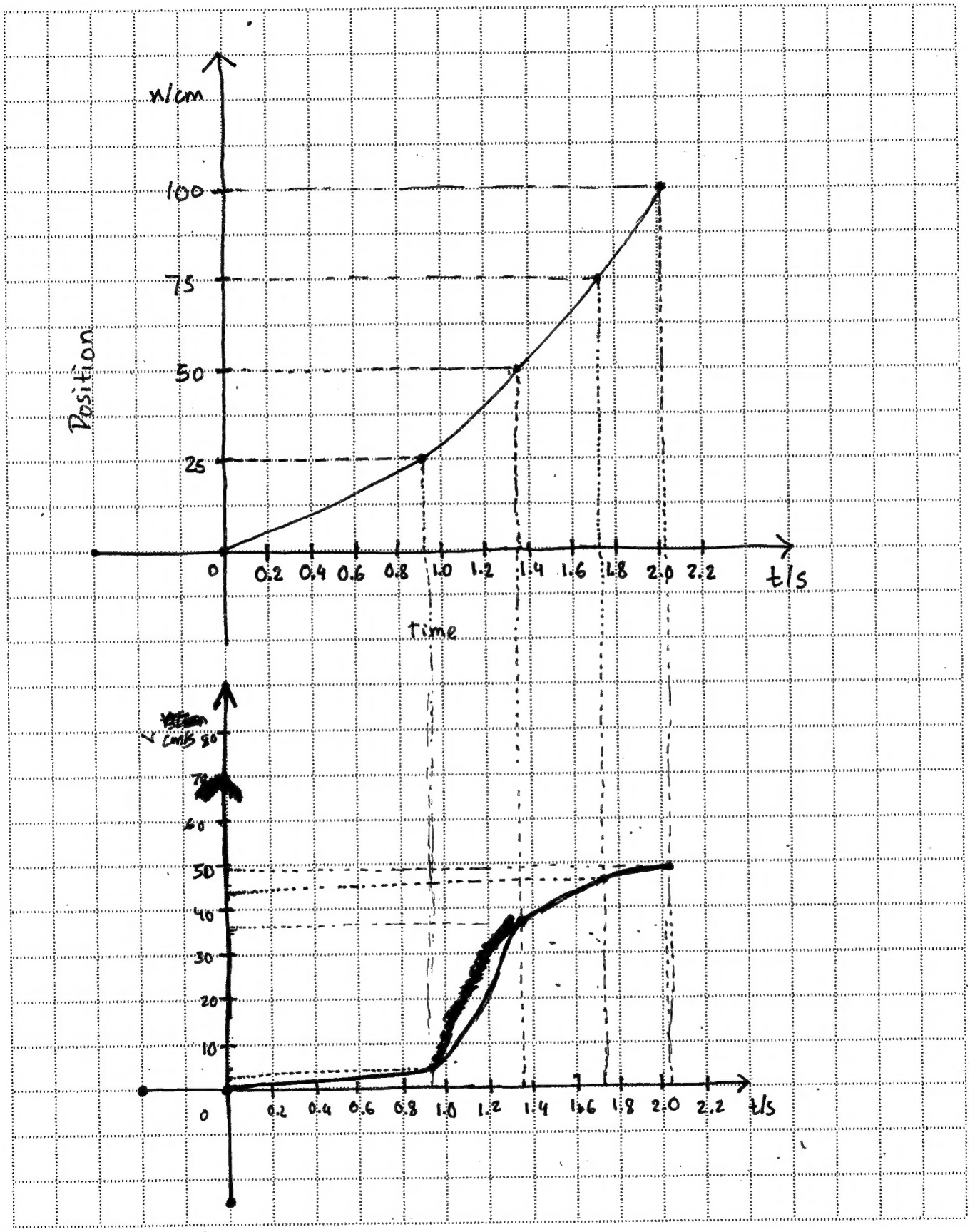
Yes

7) *Does the final velocity ($X_{end\ of\ ramp} - X_{.75}$) at the end of the ramp match the final **average** velocity. If not, why?*

~~83.4-68.6=14.8~~ No, because acceleration is greater than 0 and velocity is increasing, while avg. velocity is lower due to lower velocities earlier.

8) *Based on your data try to find the distance traveled (use area under the curve by counting the boxes in the graph paper) using the **velocity graph**?*

100 cm/1 m.

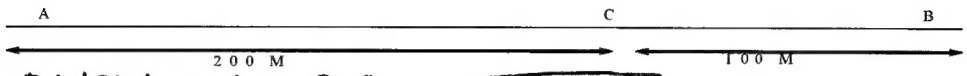

x/cm
100
75
50
25
Position
0
0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2
t/s
Time
80
70
60
50
40
30
20
10
0
0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2
t/s

# Velocity 2

1) A jogger jogs from one end to the other of a straight 300 m track (from point a to point **b**) in 2.5 min and then turns around and jogs 100 m back toward the starting point (point **c**) in another 1.0 min. a) What are the jogger's average speeds and velocities in going from **a** to **b**? b) From **a** to **c**?

a) Avg. speed = $\frac{\text{Total Distance}}{\text{Total Time}} = \frac{300\text{ m}}{(2.5\times60)\text{s}} = \boxed{2\text{ m/s}}$ = Avg. velocity

b) Avg. speed = $\frac{\text{Total Distance}}{\text{Total Time}} = \frac{300+100}{(3.5\times60)} = \frac{400}{3.5\times60} = \boxed{1.9\text{ m/s}}$




• Avg. velocity = $\frac{\text{Total Displacement}}{\text{Total Time}} = \frac{200}{3.5\times60} = \boxed{0.95\text{ m/s}}$

c) Suppose a second jogger follows the path of the first jogger but continues through point **c** back to point **a**. with the addition of 1.5 min. what is new velocity and speed?

• New velocity = $\frac{\text{Total Displacement}}{\text{Total Time}} = \frac{0}{(5\times60)} = \boxed{0\text{ m/s}}$ • New speed = $\frac{(300\times2)}{(8\times60)} = \boxed{2\text{ m/s}}$

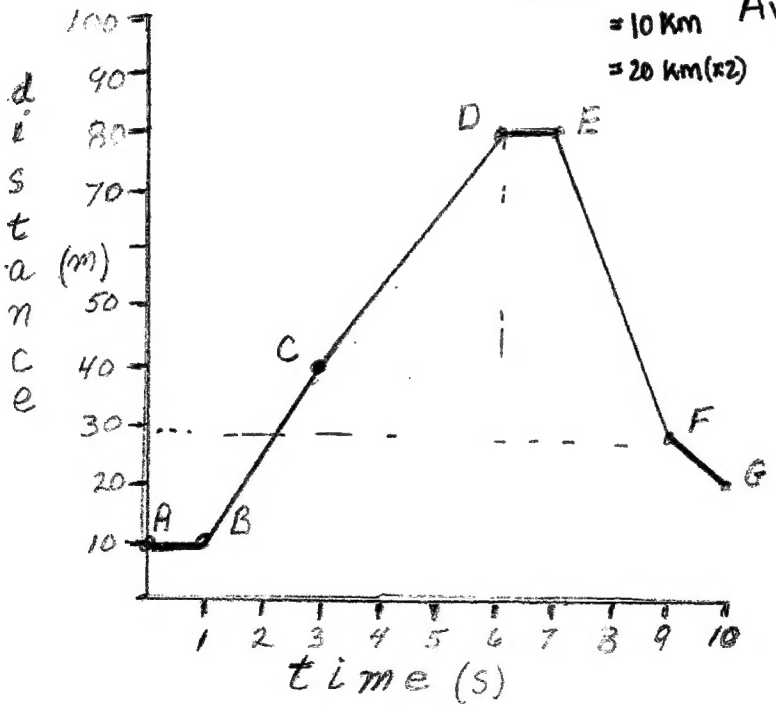
2) In driving the usual route to school, a student computes the average speed for the trip to be 20 km/hr in 30 minutes. On the return trip along the same route, there is less traffic and the average speed is 30 km/hr. What is the average speed for the total trip?

Total D = 20×0.5
= 10 Km
= 20 km(×2)

Avg. speed = $\frac{(10\times2)\text{ km}}{\frac{1}{3}+0.5\text{ hr}}$

$= \frac{20\text{ km}}{\frac{5}{6}\text{ hr}}$

$= 20\times\frac{6}{5} = \boxed{24\text{ km/hr}}$




3) What is the average velocities for ab, bd, de, af, and fg?

Avg velocity = $V_{avg.}$

$V_{avg.(ab)} = \boxed{0\text{ m/s}}$

$V_{avg.(bd)} = \frac{80-10}{6-1} = \frac{70}{5} = \boxed{14\text{ m/s}}$

$V_{avg.(de)} = \boxed{0\text{ m/s}}$

$V_{avg.(af)} = \frac{30-80}{9-7} = \frac{-50}{2} = \boxed{-25\text{ m/s}}$

$V_{avg.(fg)} = \frac{20-30}{10-9} = -\frac{10}{1} = \boxed{-10\text{ m/s}}$

# Velocity Review

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*1) speed is a) a measure of how fast something is moving b) the distance covered per unit time c) always measured in terms of a unit of distance divided by a unit of time* (d) *all of the above*

*2) one possible unit of speed (not si unit, only) is* (a) *miles per hour b) kilometers per hour c) cm per sec. d) all of the above*

*3) when you look at the speedometer in a moving car, you can see the car's* (a) *instantaneous speed* (b) *average speed c) instantaneous acceleration d) average acceleration*

*4) suppose you take a trip that covers 240 km in 4 hours. your average speed is* (a) *60 km/hr b) 480 km/hr c) 240 km/hr d) 120 km/hr*

*5) which of the following is scalar (denote with a star), which is a vector (denote with a bumble bee)?*
*a) speed* ★ *b) distance* ★ *c) velocity* 🐝
*d) acceleration* 🐝 *e) displacement* 🐝

*true or false*
*6) the rate at which distance is covered is called speed.* True

*7) average speed is defined as the time it takes for a trip divided by the distance* False

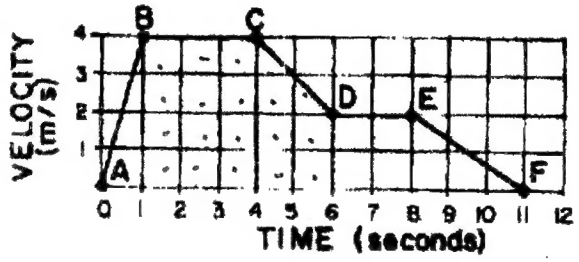
*8) velocity is different from speed in that velocity is speed in a given direction* True

*9) the si unit for velocity is the meter.* False

*10) the distance traveled by the object during the first 4 s is* 14 m.

$\frac{1}{2} \times 1 \times 4^2 + 12 + C = 20$

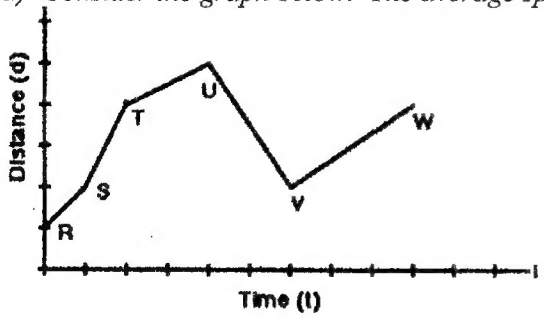
$\frac{2+0}{6} = \frac{1}{3}$




$\frac{2-0}{6-0} = \frac{1}{3}$

*11) the average velocity of the object from point a to point d is* $\frac{1}{3}$ m/s.

*12) Consider the graph below. The average speed is greatest during interval. How far did it travel?*




~~9 meters~~.

$1 + 2 + 1 + \frac{3}{3} + 2$

= 9 units

# Velocity Homework

1) Every speedometer of a car has an odometer that records distance traveled. If the odometer tells us we have traveled 35 kilometers in a half hour. What is our average speed? 70 km/h.

2) If a cheetah can maintain a constant speed of 25 m/s. It will cover 25 meters every second. How far will it travel in 10 seconds? In one minute? 250 m & 1500 m

3) If a car traveled 10 km in 45 minutes, what is its average speed? $10 \times \frac{60}{45} = \frac{600}{45} = 13.\overline{3}$ km/h.

4) When the speedometer gives you a reading as you drive, is it an average velocity or instantaneous velocity? Average speed.

5) Speed is a) the measure of how fast something is moving b) the distance covered per unit of time c) always measured in terms of a unit of distance by a unit of time (d) all of the above

6) Speed is the rate at which **what** happens? $\Delta$ distance / $\Delta$ time

7) The difference between speed and velocity is?

Speed has magnitude.
Velocity has both magnitude & direction.

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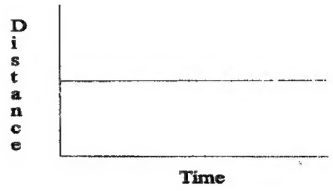
# Displacement Graphing II

*Answer the following questions in the spaces provided.*

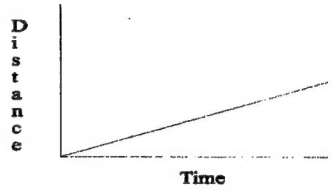
*1. What do you do to create a horizontal line on a distance-time graph?*

No movement.



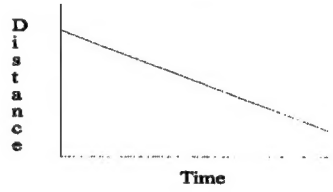

*2. How do you walk to create a straight line that slopes up?*

Walk at a constant speed away from original point.



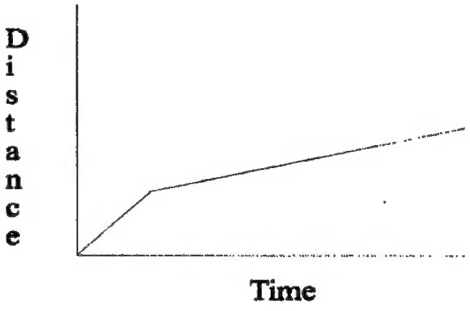

*3. How do you walk to create a straight line that slopes down?*

Walk at a constant speed toward the original speed




*4. How do you move so that the graph goes up steeply at first, and then continues up gradually?*

Walk at faster constant speed initially, then walk at slower constant speed away from original



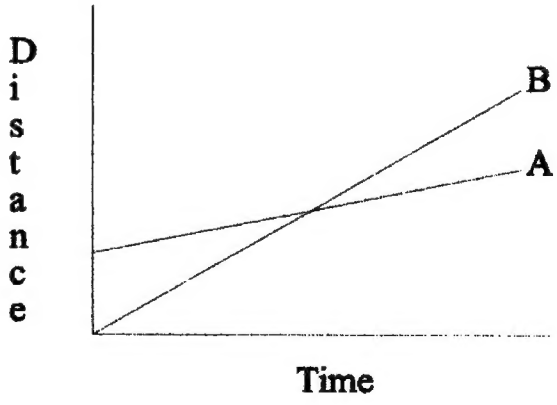

*5. a) Which object has the higher speed--A or B?*

B

*b) Which starts ahead?* A *Define what you mean by "ahead."* Farther from the origin

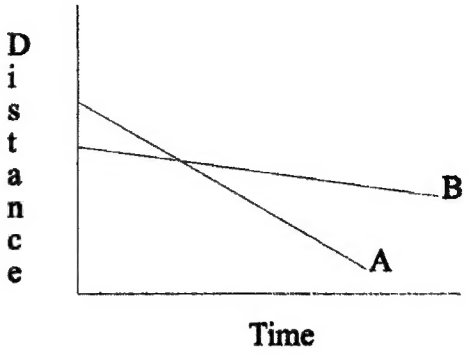
*c) What happens to the objects at the intersection?*

They would meet.

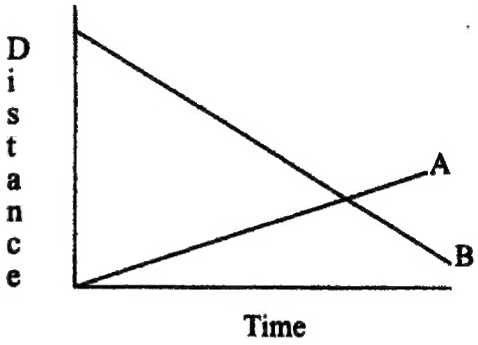


# Displacement Graphing II

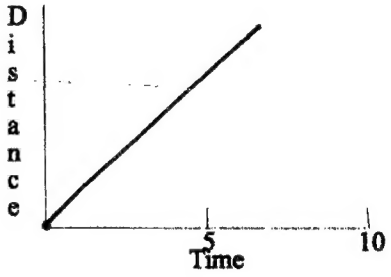
6. a) Which object has the higher speed? A
b) Which object has a negative velocity?
None.



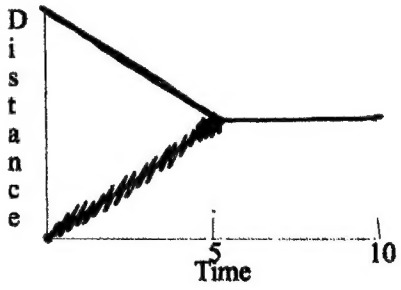

7. a) Which object has the higher speed? B
b) Which starts ahead? B Explain what you mean by "ahead." Further from the original



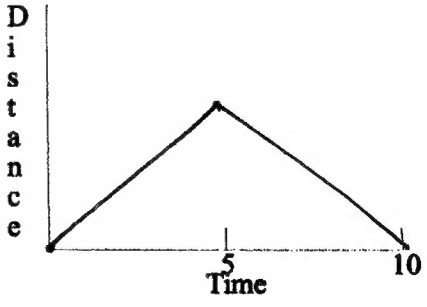

8. The object moves with a steady (constant) velocity away from the origin.




10. The object moves with a steady (constant) velocity toward the origin for 5 seconds and then stands still for 5 seconds.




11. The object moves with a steady velocity away from the origin for 5 seconds, then reverses direction and moves at the same speed toward the origin for 5 seconds.



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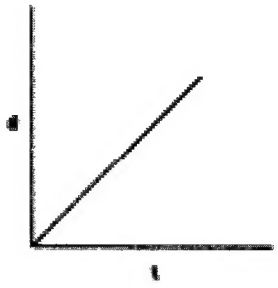
1) *Which one of the following statements correctly describes the motion of an object depicted by the graph in?*



*(1) The object has non-uniform motion.*
*(2) The object has constant velocity.*
*(3) The object has increasing velocity.*
*(4) The object has constant non-zero acceleration.*
*(5) The object has increasing acceleration.*

2) *Which of the following examples does NOT illustrate uniform motion?*
*(1) A ball rolls along a table without changing velocity. (2) A mass is thrown vertically upward at 10 m/s. (3) A jogger runs 50 m along a straight track at constant speed. (4) An elevator moves vertically upward past four floors at zero acceleration. (5) An elevator sits at rest between two floors, where g= 10 N/kg.*

3) *If a body travels at constant speed, then the distance it travels varies directly as the time elapsed.*
*(1) True (2) False*

4) *An object has uniform motion if (1) its speed is constant. (2) it travels in a straight line. (3) its velocity is constant. (4) its acceleration is constant. (5) it travels in a circle at constant speed.*

5) *Which of the following motions is uniform? (1) a child on a merry-go-round traveling at constant speed. (2) a parachutist falling vertically at constant speed. (3) a satellite in orbit around the earth. (4) a soccer ball rolling on a grass field. (5) an object accelerating at 10 m/s$^2$ every second.*

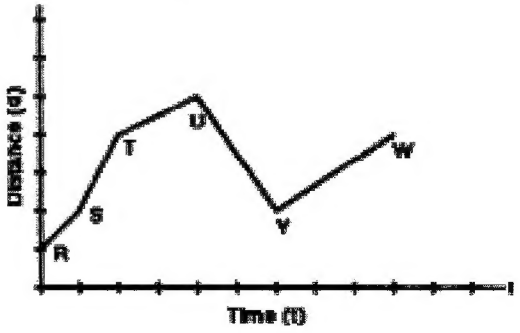
6) *Displacement is a unit of measurement.* *(1) True (2) False*

7) *A tape from a laboratory experiment has the appearance shown in the diagram. The dots were made by a vibrator with steady frequency of 20 Hz. The total elapsed time between dot W and dot M is*

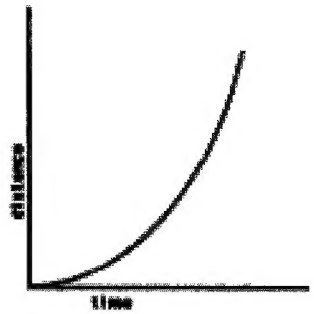
*(1) 6.0 s (2) 0.30 s (3) 0.35 s (4) 3.0 s (5) 3.5 s*

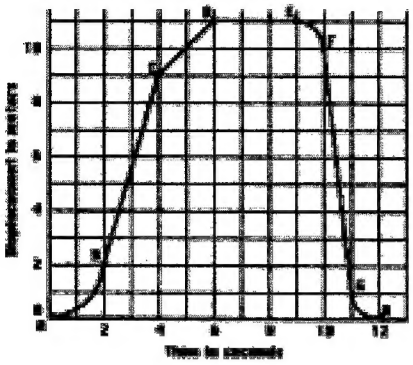
8) *A radar transmitter sends out a pulse which is reflected from the Moon's surface. The signal returns 2.7 s after it is sent. What is the best estimate of the Moon's distance from the Earth if light travels at 3 x 10$^8$ m/s?*
*(1) 0.55 x 10$^8$ m (2) 1.1 x 10$^8$ m (3) 4.0 x 10$^8$ m*
*(4) 8.1 x 10$^8$ m (5) 16.2 x 10$^8$ m*

9) *Consider the graph. The average speed is greatest during interval (1) RS (2) ST (3) TU (4) UV (5) VW*



*10) The graph represents the relationship between distance and time for an object moving in a straight line. According to the graph, the object is (1) motionless (2) moving at a constant speed (3) decelerating (4) accelerating*





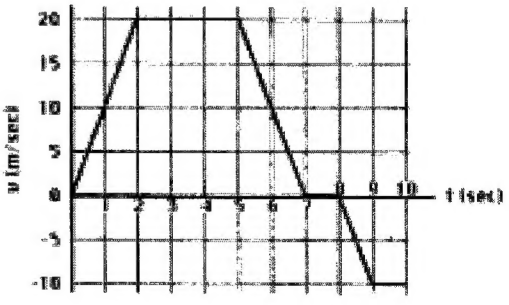
*11) What is the average velocity of the cart during the part of the trip labeled CD?*
*(1) 1 m/s (2) 2 m/s (3) 10 m/s (4) 11 m/s*

*12) A car traveled up a hill at a constant speed of 10.0 km/hr and returned down the hill at a speed of 20.0 km/hr. If the time needed to turn around is ignored, what was the average speed for the total trip?*
*(1) 0 (2) 13.3 km/hr (3) 15.0 km/hr (4) 16.7 km/hr (5) There is not enough information to answer the question.*

*13) The average velocity of an object during 6.0 s is 2 m/s. What is the total distance traveled by the object?*
*(1) 1/3 m (2) 12 m (3) 3 m (4) 4 m*

*14) A car starts from Hither, goes to Yon, and returns. The round-trip distance of 100 km takes 2 hr. The magnitude of the average velocity for the round trip is*
*(1) 0 km/h (2) 50 km/h (3) 100 km/h (4) 200 km/h (5) 0.02 km/h*

*15) For the time interval t = 0 s to t = 2 s, how many meters will the cart travel? (See diagram)*
*(1) 10 (2) 20 (3) 30 (4) 40*



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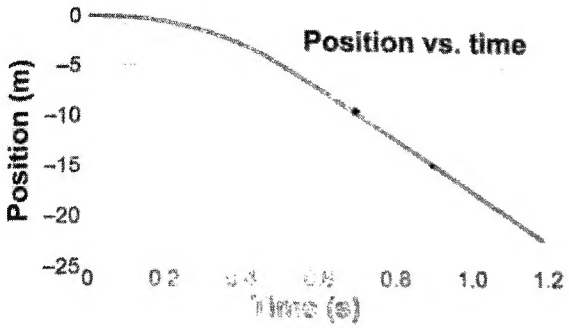
# Position and Velocity Graphs



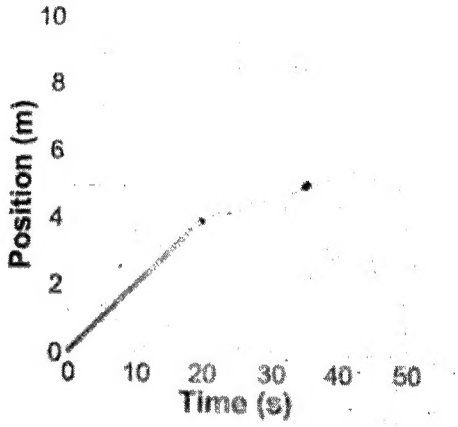

1) The position vs. time graph represents the motion of a foam ball after being dropped. What is the instantaneous velocity at .8 sec?

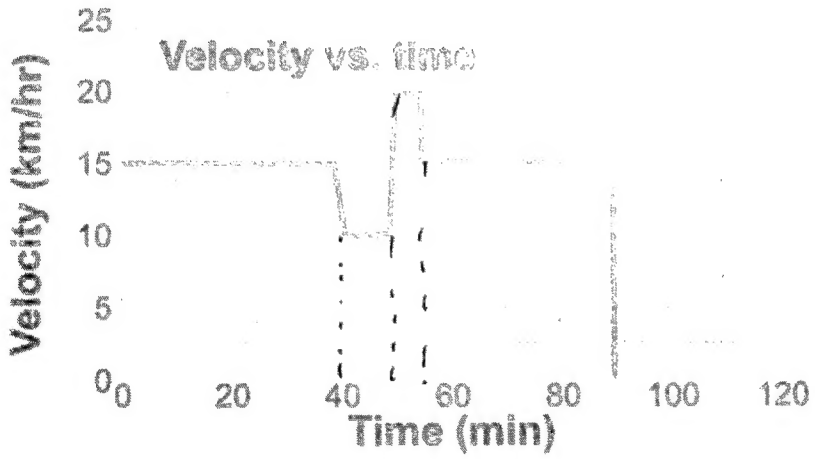
1) $\frac{-15+10}{0.9\ \ 0.7} = \frac{-5}{0.2} = -5 \times \frac{10}{2} = -25$ m/s

2) In the position vs. time graph how far does the object travel in the first 35 seconds?

~~4+5=9 meters.~~

=5 meters




3) The velocity vs. time graph shows a bicycle trip. Use the graph to calculate the following.

a) How many km. does the cyclist travel?

b) What is the cyclist's final position?

c) Which segment of the trip is most likely to have been downhill?

a) $\frac{40}{60} \times 15 + \frac{10}{60} \times 10 + \frac{5}{60} \times 20 + \frac{35}{60} \times 15$

= 22.08 km

b) 22.08 km ahead

c) Around 49-50 mins.

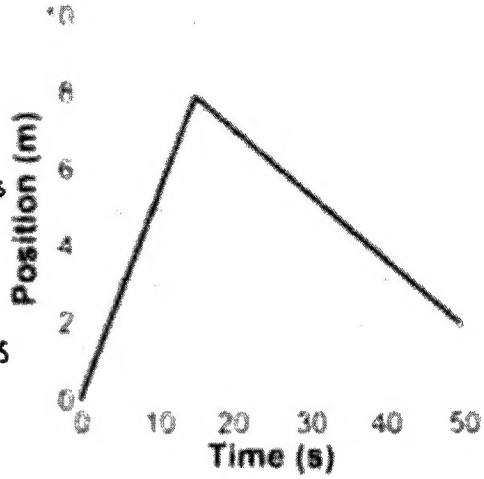
# Position and Velocity Graphs

4) Using the position vs. time graph:

a) What is the average velocity from 30 to 40 seconds? $\frac{3.5-5.5}{40-30} = -0.2$ m/s

b) What is the distance the object travels between 0 and 50 seconds? What is the ball's change in position? 14 m & 2 m

c) What is the object's velocity at t = 5 seconds? $\frac{2.5}{5} = \frac{1}{2}$ m/s




5) The graph shows the position of a robot car moving along a straight track for 6 seconds. Use the graph to answer the following questions.

a) What is the car's speed 1 second after it starts? 0.3 m/s

b) What is the maximum speed reached by the car? 0.8 m/s

c) When does the car reach its maximum speed? 5 s

d) What is the total distance the car travels between t = 0 and t = 6 seconds? 1.8 m

e) What is the car's maximum positive velocity? 0.2 m/s

$\frac{0.7-1}{1-0} = 0.3$ m/s

$\frac{0-0.8}{6-5} = -0.8$ m/s

$0.6+0.4+0.8$

$\frac{0.6-0.4}{4-3}$

$= 0.2$